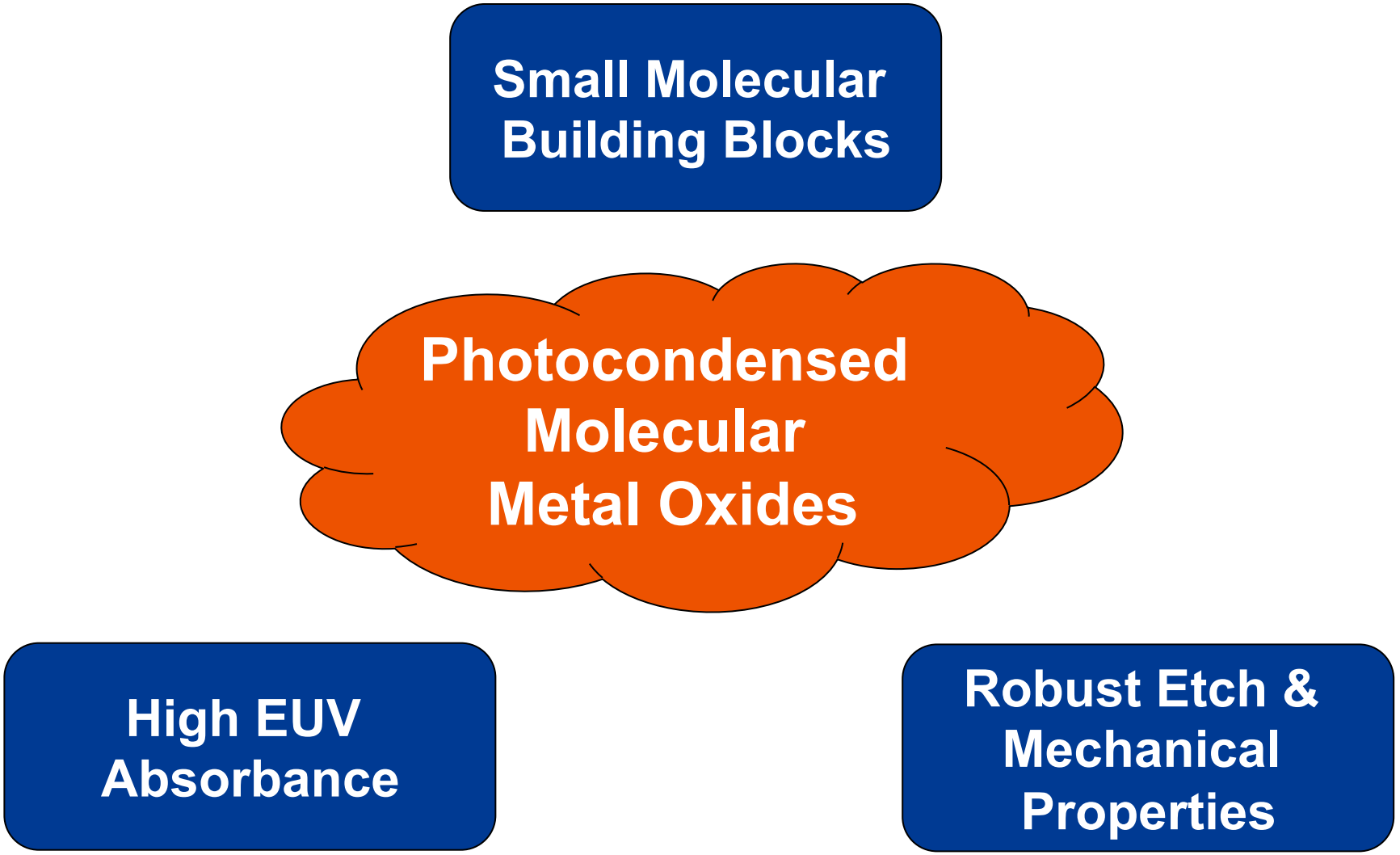
The Path from Lab to Fab

Andrew Grenville

EUVL Symposium

October 27, 2014

Inpria Design Principles



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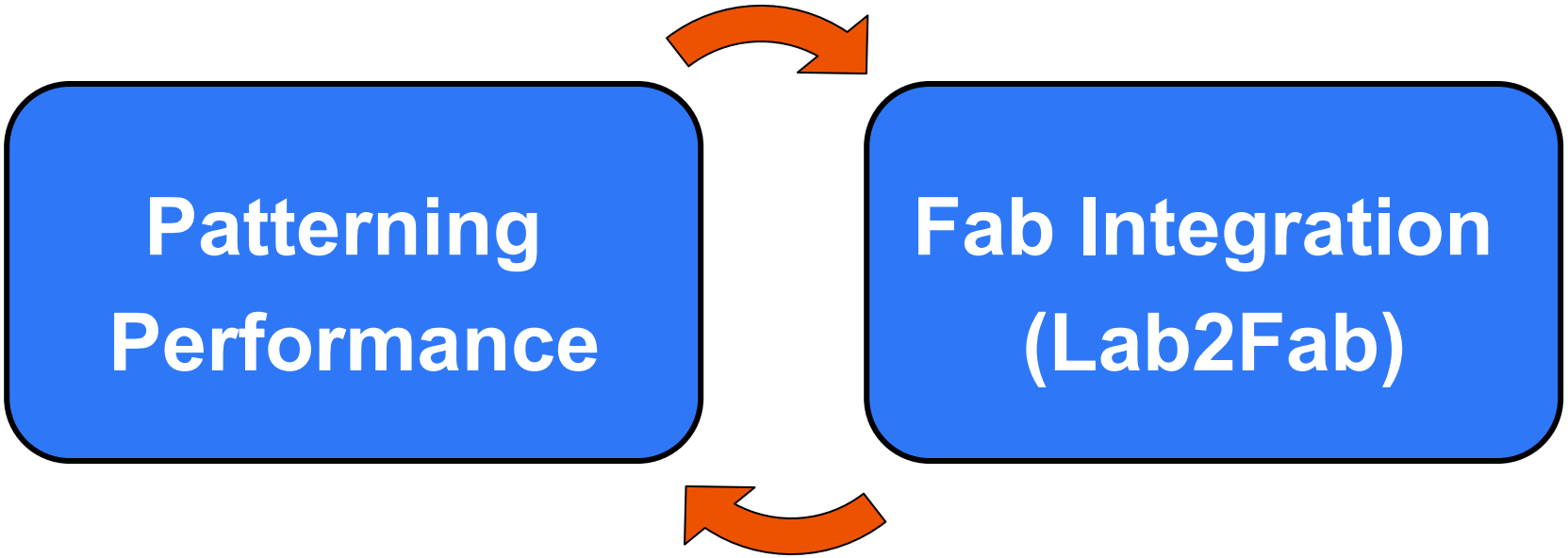
Development Strategy



PAUL SCHERRER INSTITUT PSI

BERKELEY LAB

SEMATECH

imec

+ materials, equipment, university and device manufacturer partners

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EUV Platform Development

1Q14	2Q14	3Q14	4Q14	1Q15	2Q15	3Q15	4Q15

YA-AA

First in Gen 2 family

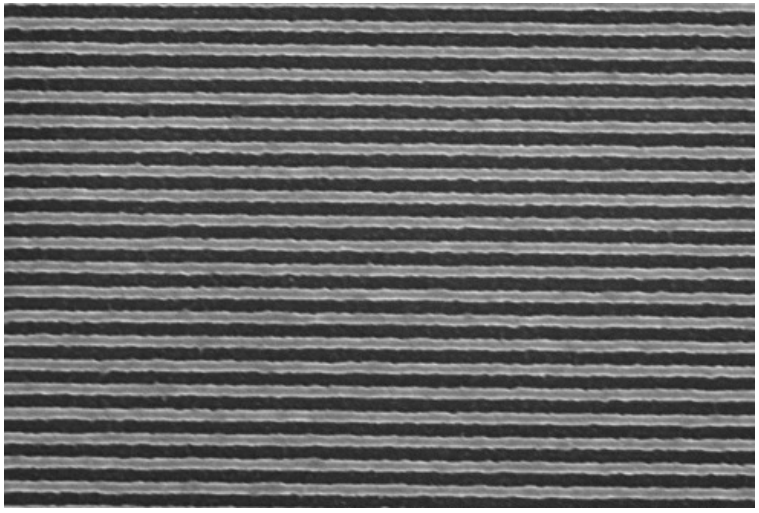
Resolution

Low sensitivity

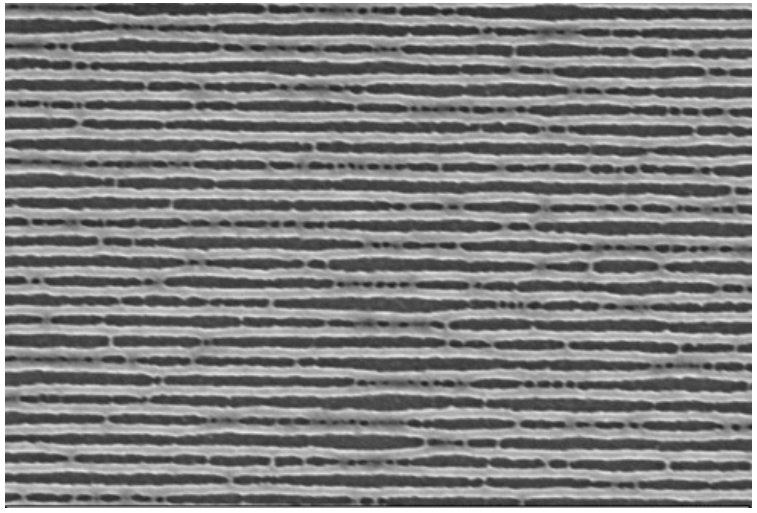
Insufficient contrast

SPIE'14

First integration proxy material



22nm HP: ~90 mJ/cm²



16nm HP: ~90 mJ/cm²

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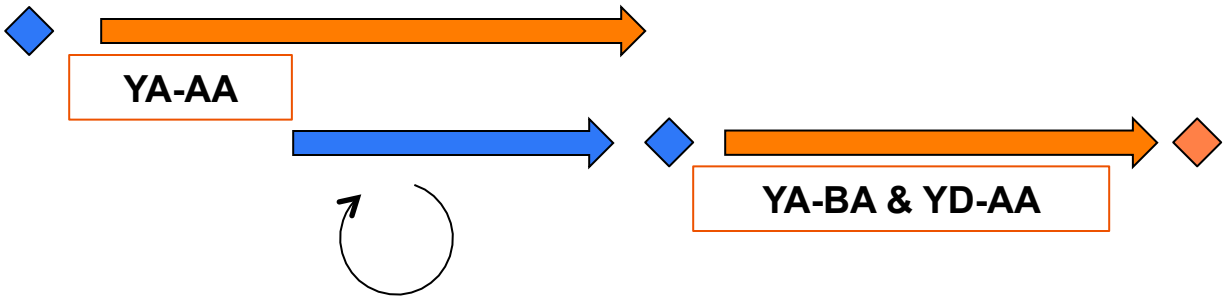
EUV Platform Development

1Q14	2Q14	3Q14	4Q14	1Q15	2Q15	3Q15	4Q15



- Substantially improved sensitivity and contrast
- Conventional organic solvents for casting & develop
- Negative tone

- Sn based: absorbance 19/µm (~4-5X typical CAR)
- Target film thickness ~22-30nm

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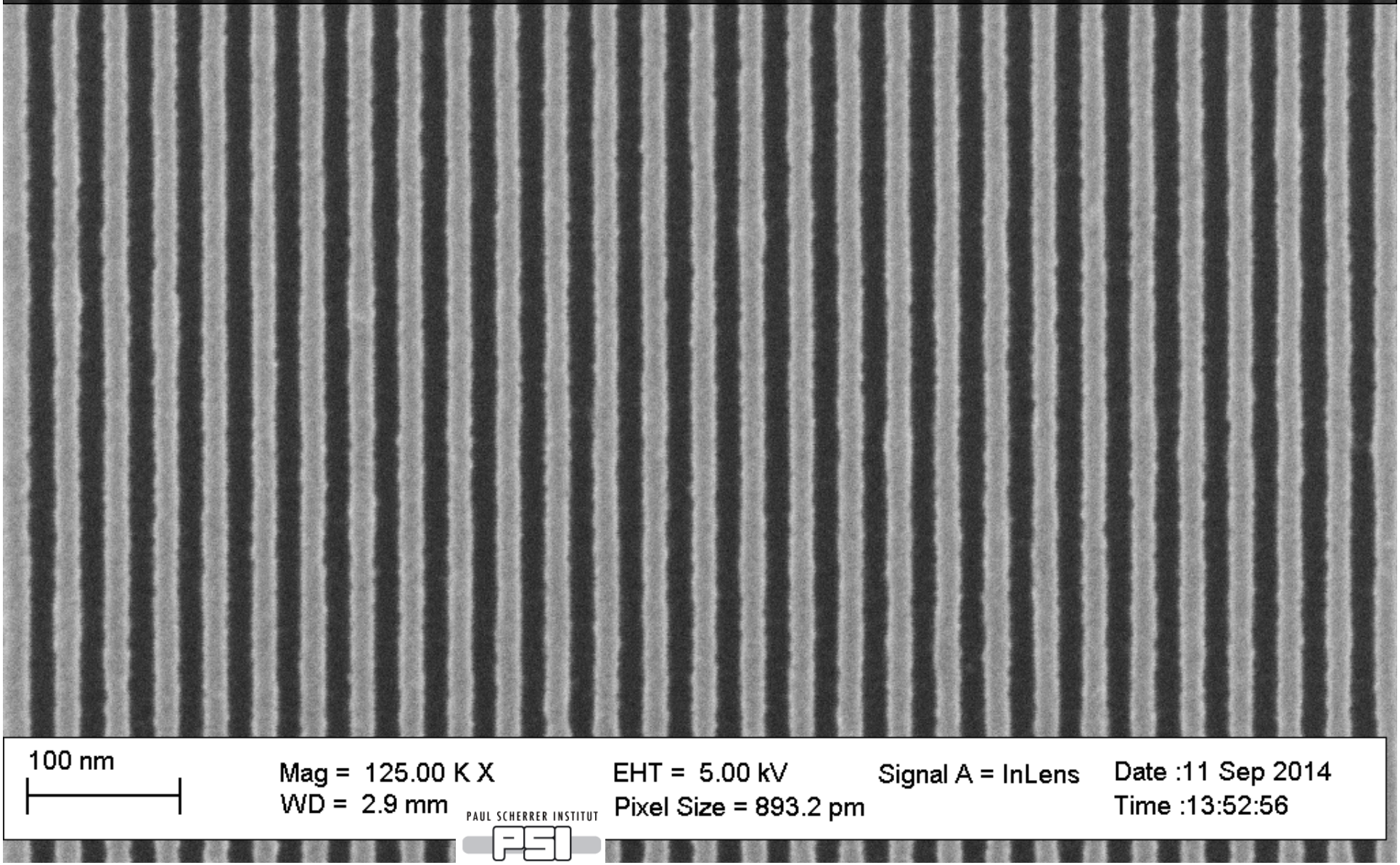
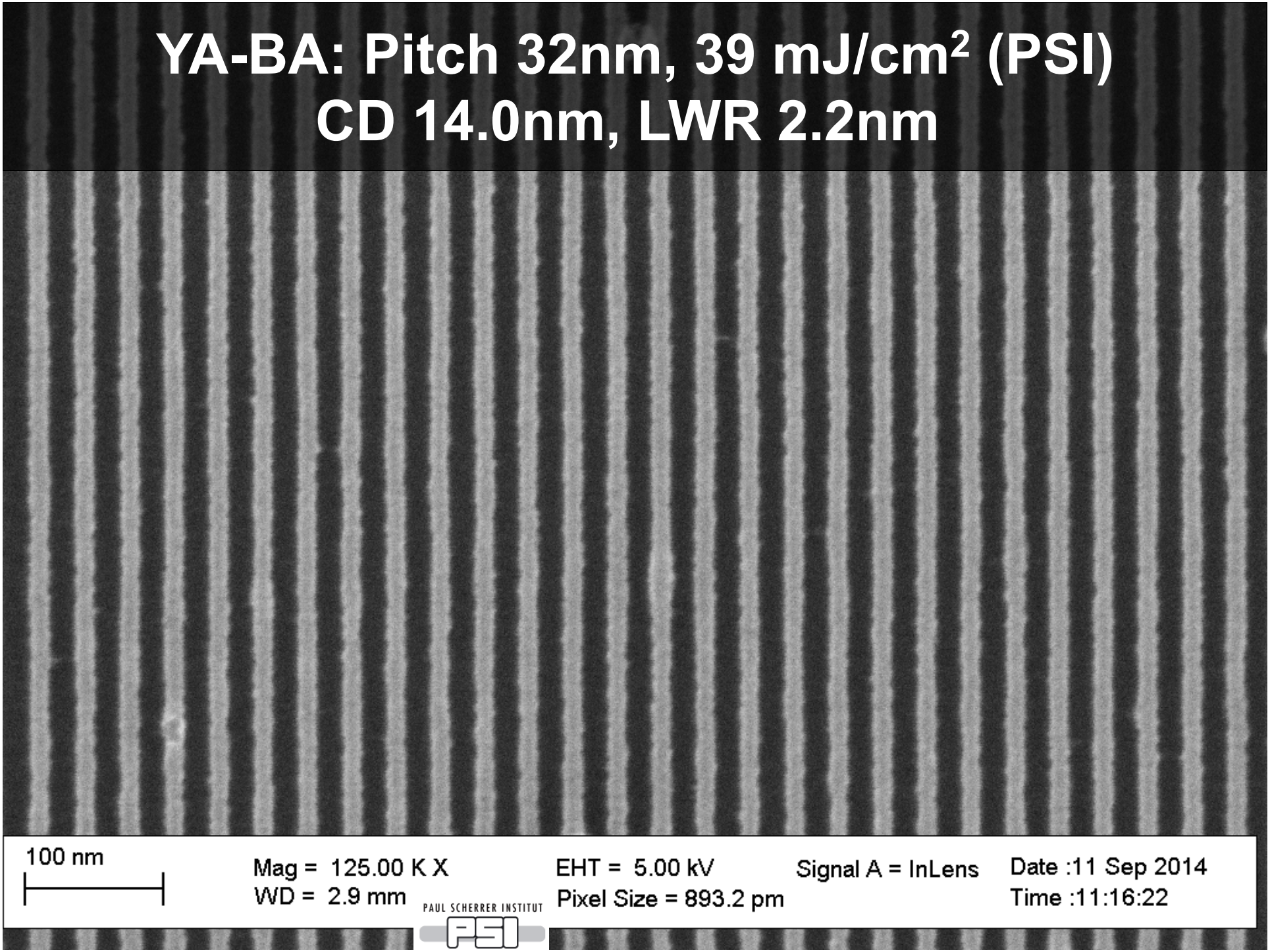
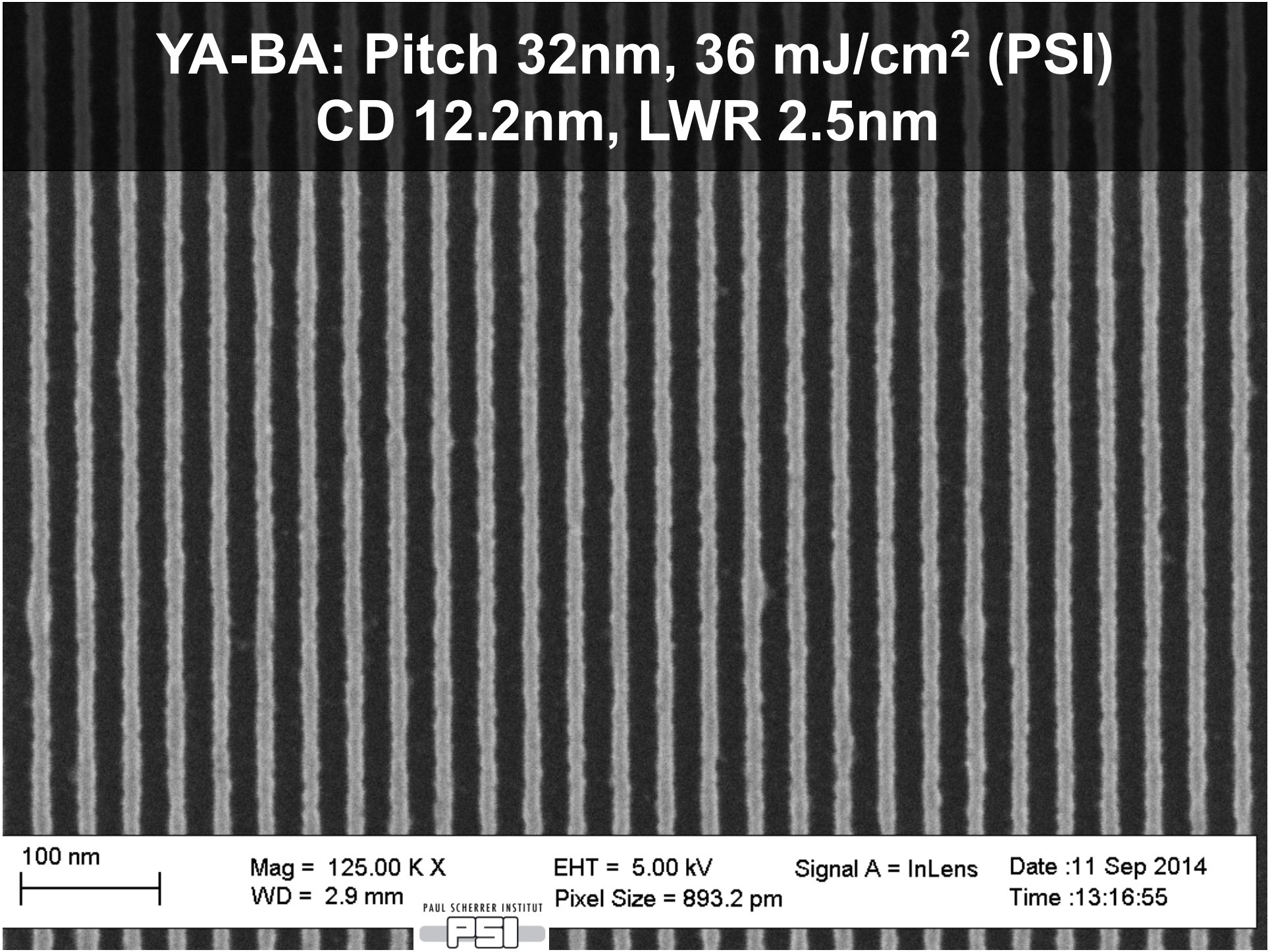
YA-BA: Pitch 32nm, 59 mJ/cm^2 (PSI)
CD 16.5nm, LWR 1.7nm



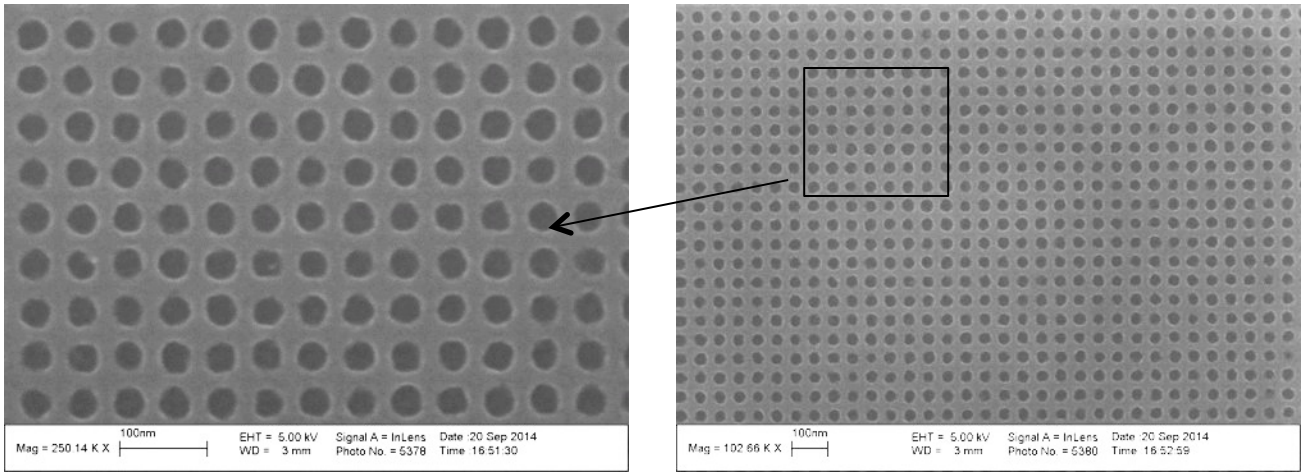
YA-BA: Pitch 32nm, 39 mJ/cm^2 (PSI)
CD 14.0nm, LWR 2.2nm



YA-BA: Pitch 32nm, 36 mJ/cm^2 (PSI)
CD 12.2nm, LWR 2.5nm



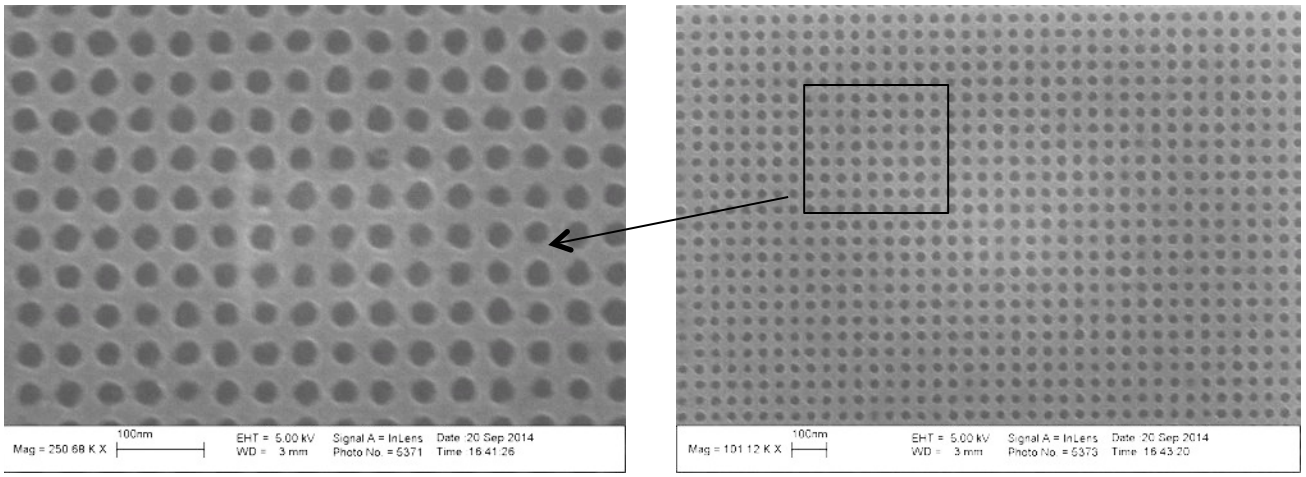
YA-BA Contact Imaging (BMET)



26nm 1:1 Contacts

36mJ/cm^2
1.3nm CDU (1σ)

C31P44
quad illumination



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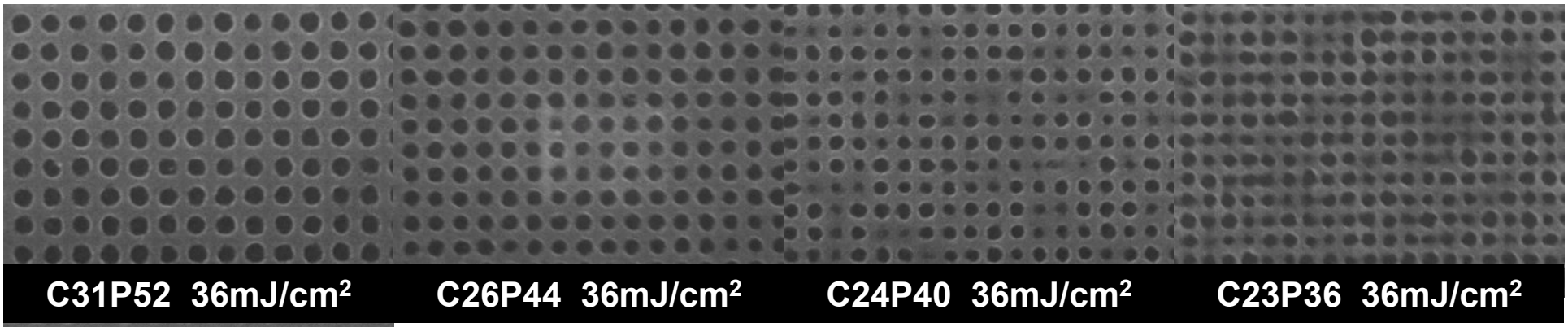
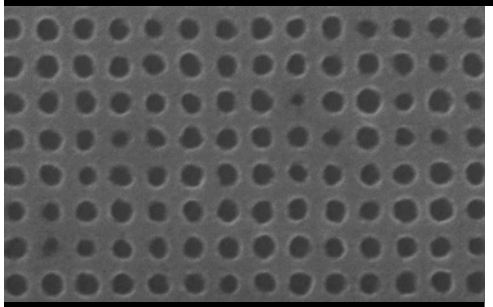
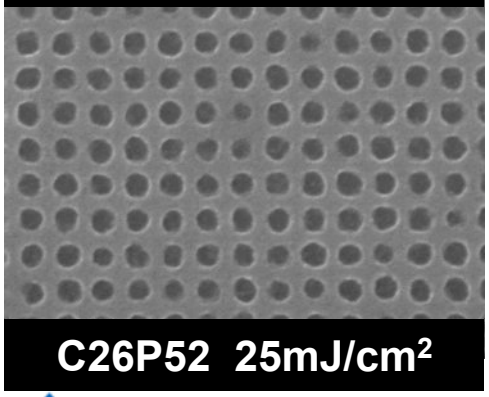






Size (26hp to 18hp)

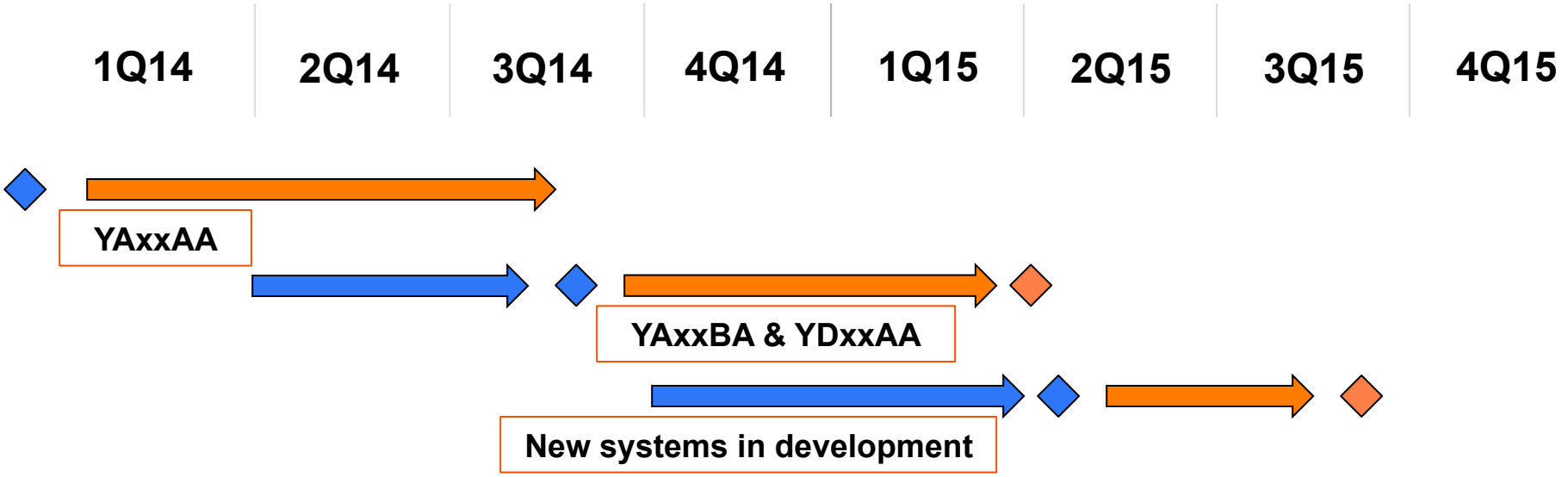
Bias

At limit of reticle

18hp ~ equivalent to 16hp on NXE3300

Quad illumination

EUV Platform Development



Further improved sensitivity and contrast

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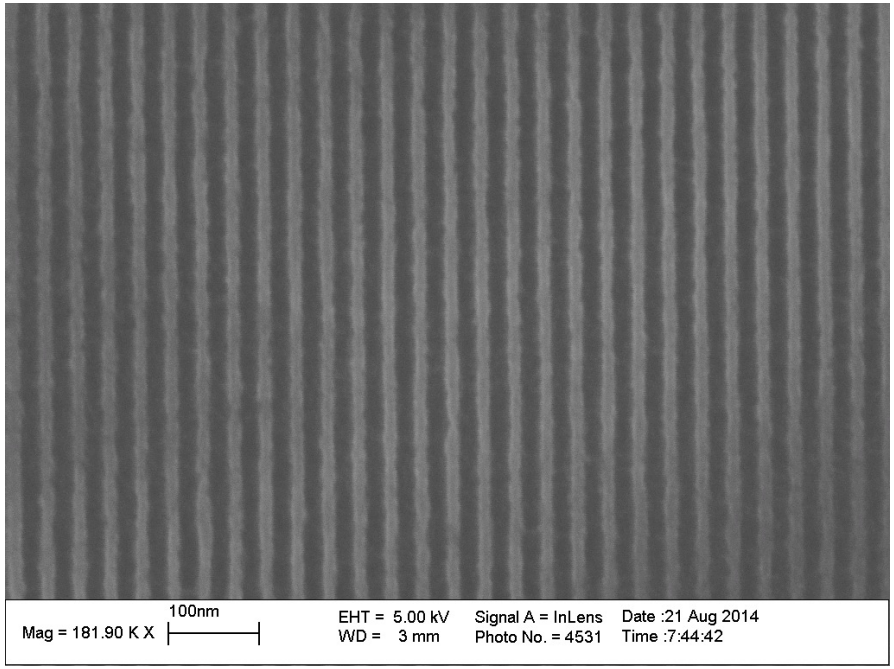
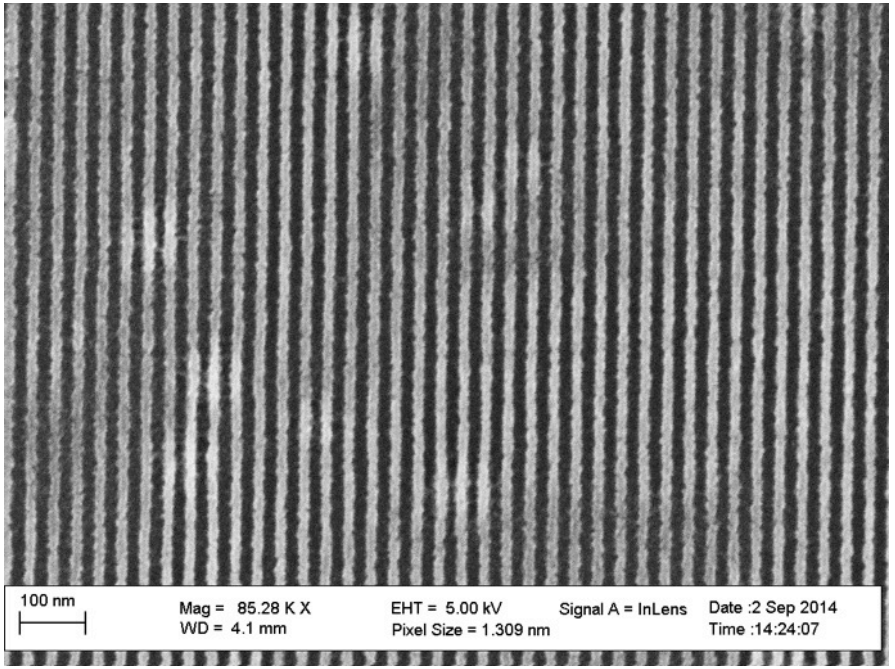
YD-AA Patterning (BMET)

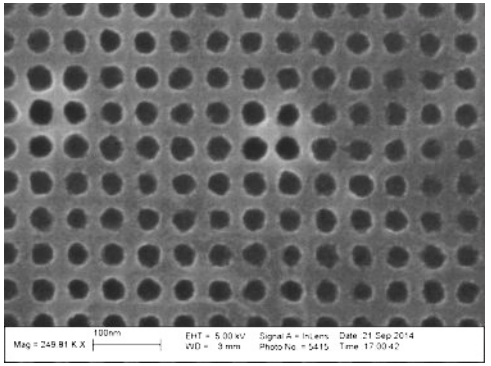


17nm hp, 40 mJ/cm^2, 3.6nm LWR



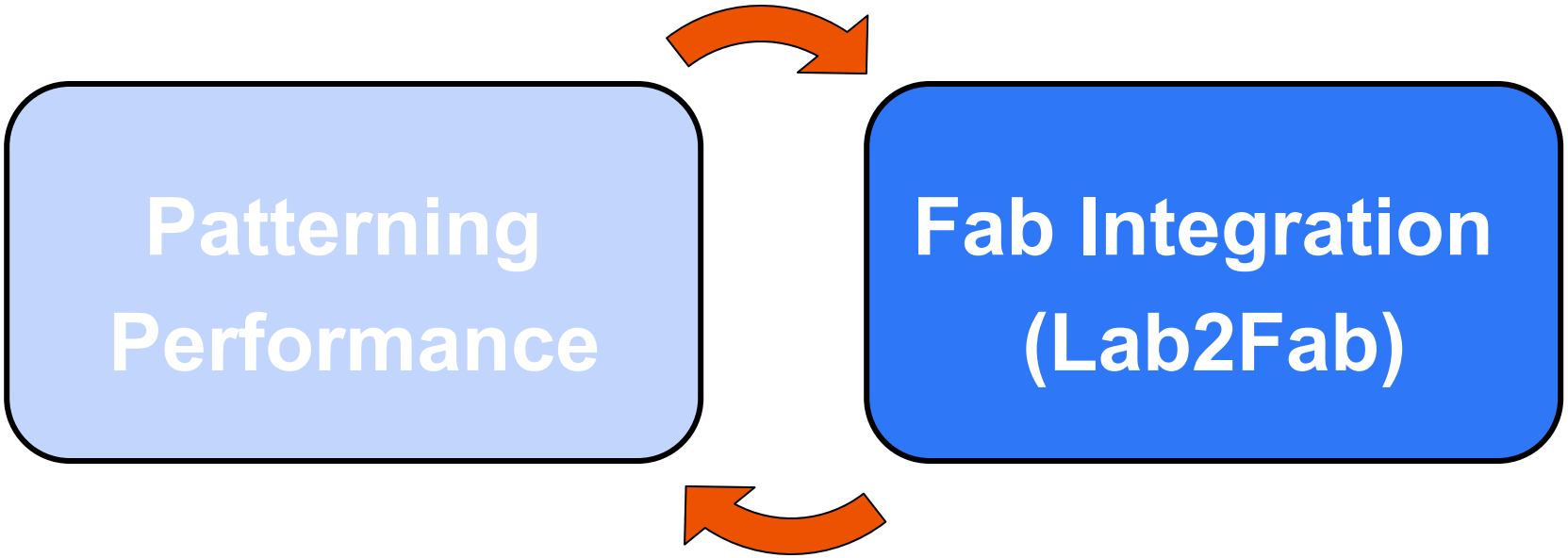
17nm hp, 32 mJ/cm^2, 4nm LWR

Initial results
Further development underway



C28P52 27 mJ/cm^2

Development Strategy



+ materials, equipment, university and device manufacturer partners

Track Integration

- Fab-compatible organic solvents
- Plumbed
  - SVDU
  - Gallon (with 5nm filter)
- Uniform coating
  - Unoptimized film thickness variation: 0.2nm (3σ)

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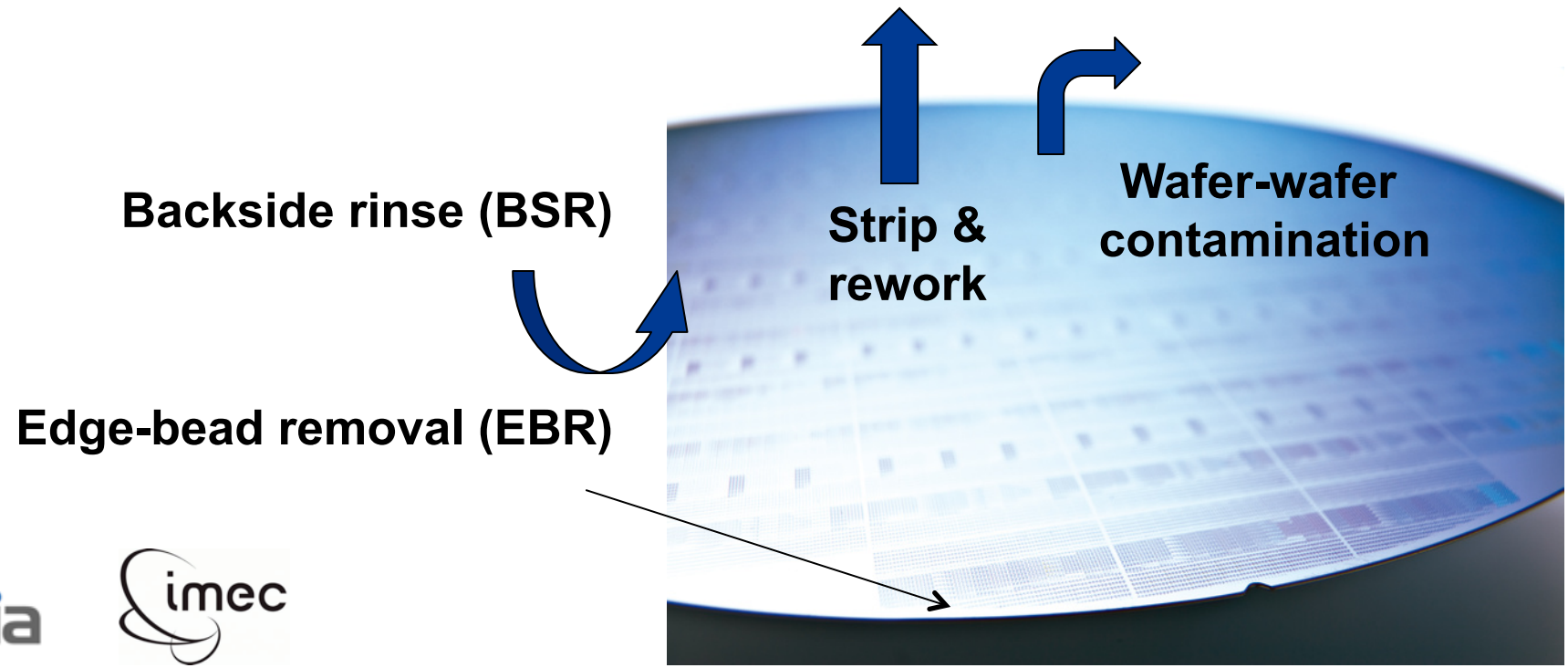
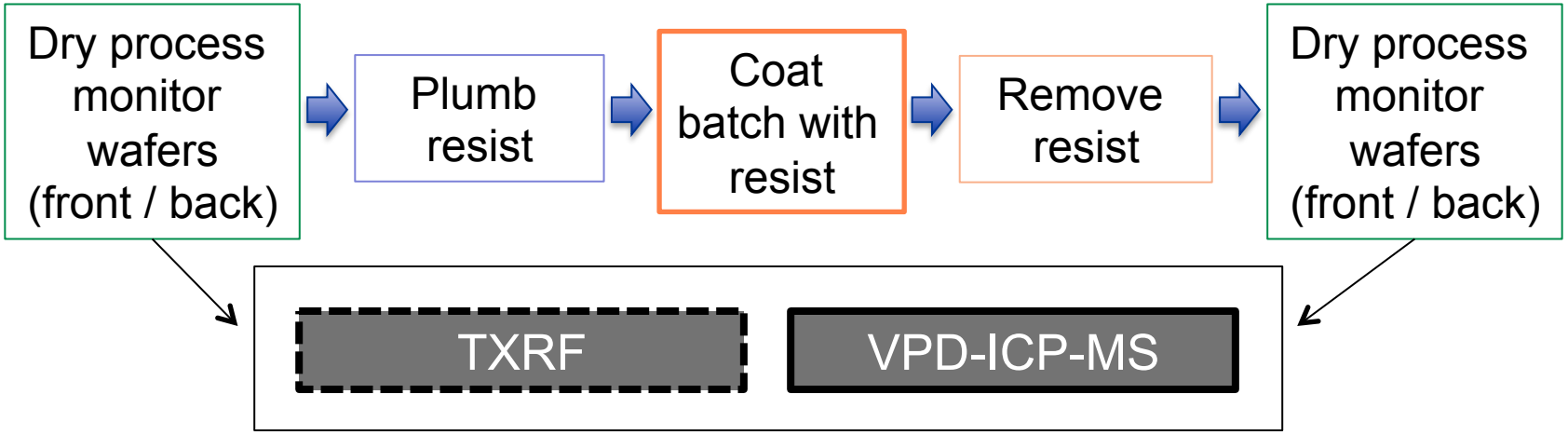
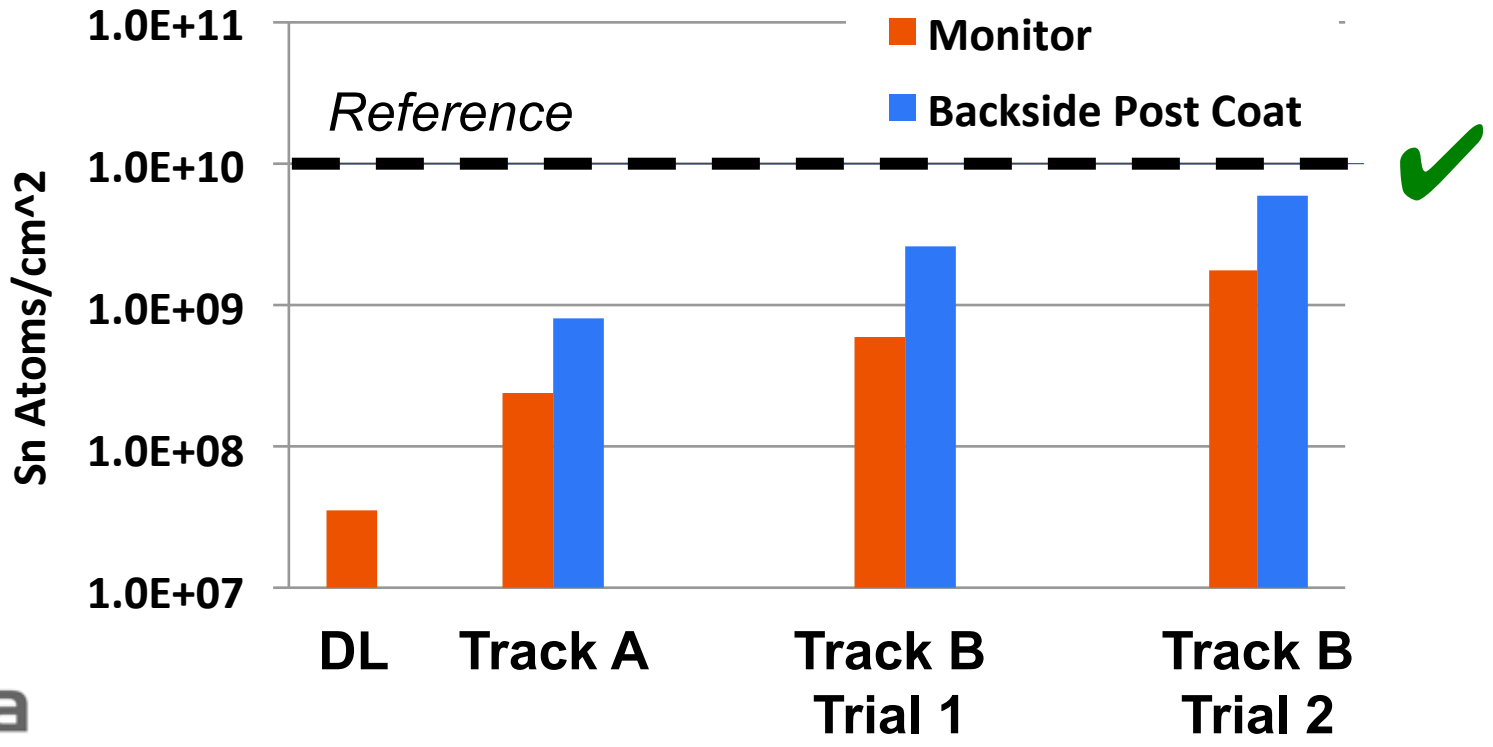
Managing Metals

Topic	Status
Backside rinse	< 1E10 atoms/cm^2
Edge-bead removal	Pending metrology
Strip & rework	~4E11 atoms/cm^2 – path to 1E10 a/cm^2



Wafer-Wafer Metal Contamination



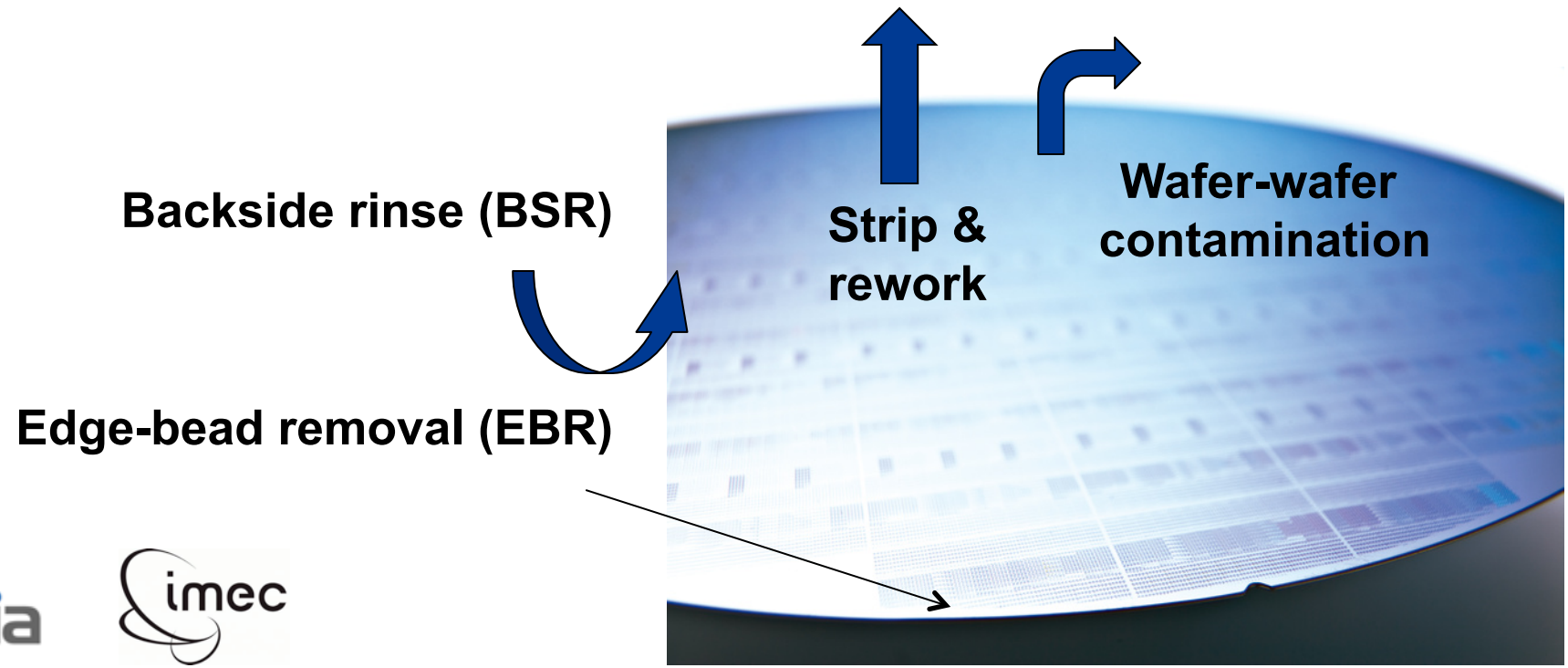


Managing Metals

Topic	Status
Backside rinse	< 1E10 atoms/cm^2
Edge-bead removal	Pending metrology
Strip & rework	~4E11 atoms/cm^2 – path to 1E10 a/cm^2
Wafer-wafer	< 1E10 atoms/cm^2

Initial processes developed with path to solution

✔



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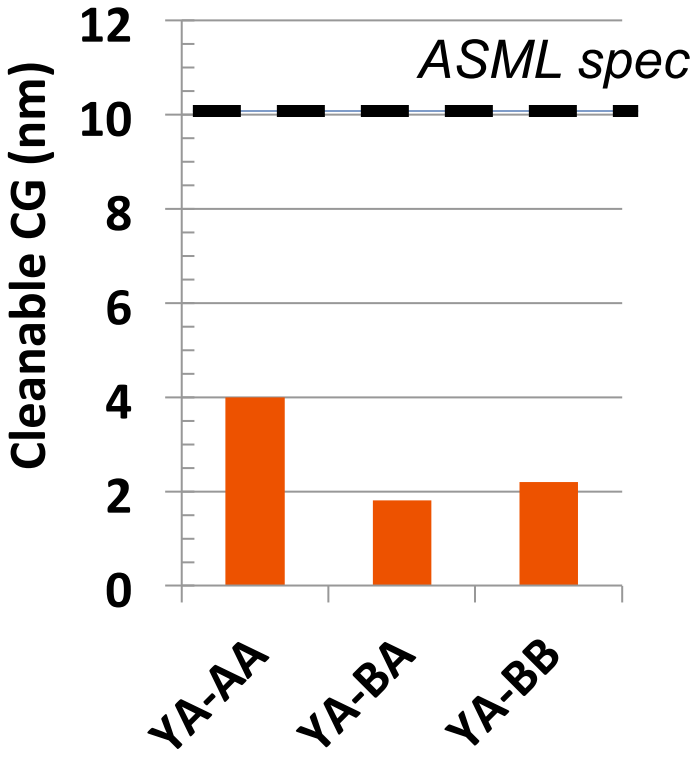
Outgassing

- Cleanables: pass
  - 3 materials tested
  - EUV & EB
  - No Sn in RGA signal
- Non-cleanables: pass
  - Undetectable (incl Sn)



- Pass conventional test
  - Provisional access to NXE3100 ✔
- Updated method under development w/ ASML
  - Film thickness vs absorbance

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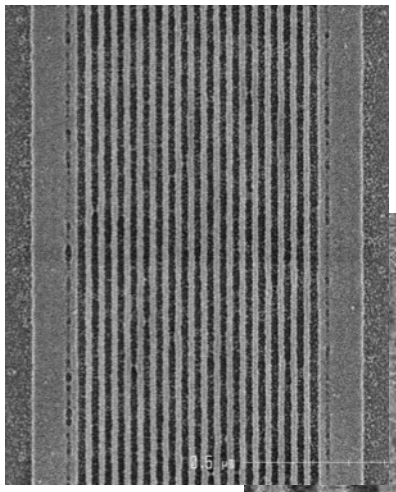
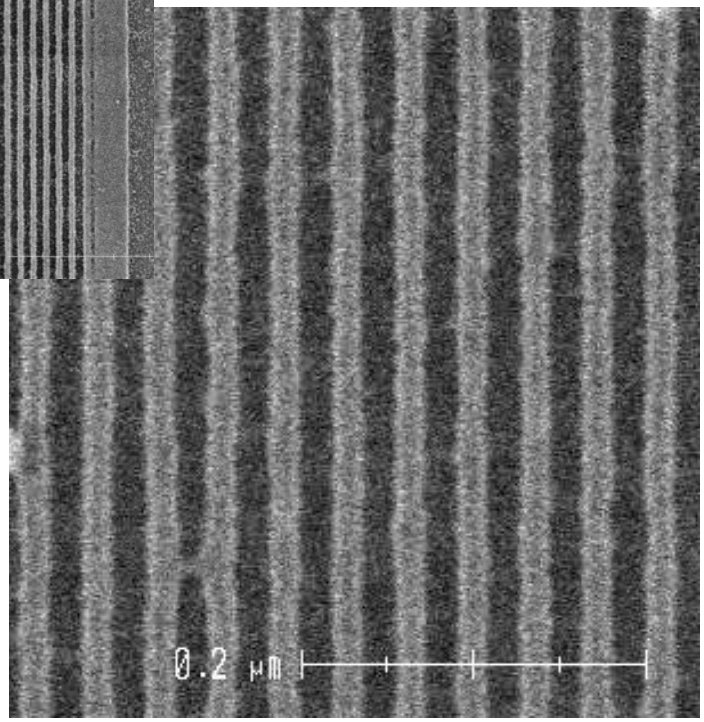
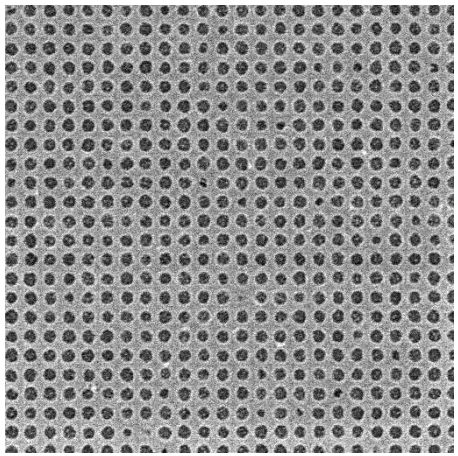
Initial Patterning on NXE3100



18nm HP
4nm LWR
85 mJ/cm^2

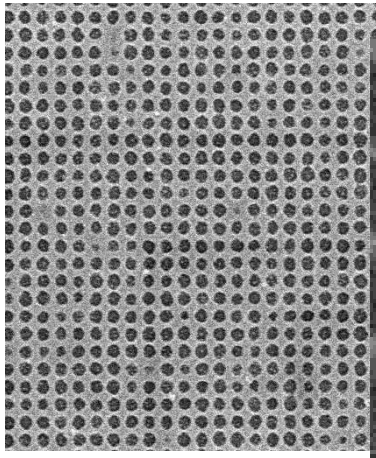


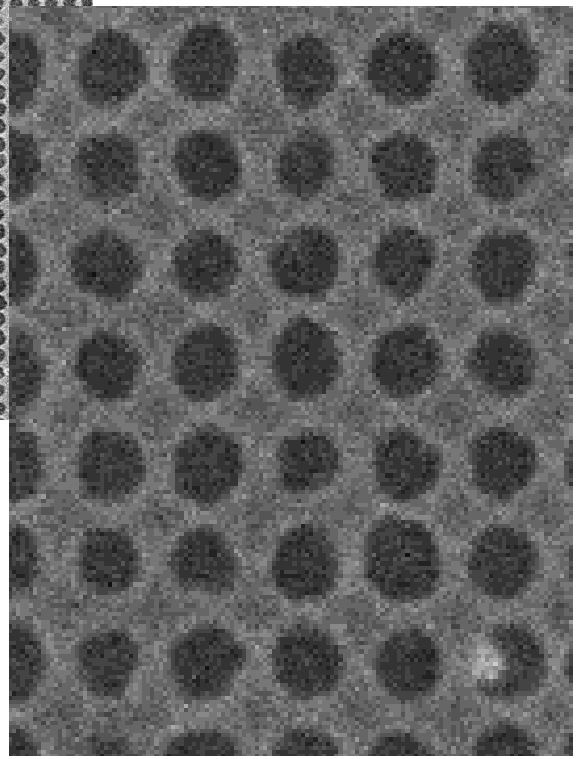
Dip60
illumination



24nm dense CH
C32P48
Quasar illumination

46 mJ/cm^2





22nm dense CH
C31P44

49 mJ/cm^2

Resist: YA80BA

Contact reticle not optimized for negative tone cell or characterized. Improved LCDU expected with reticle targeted for negative tone.

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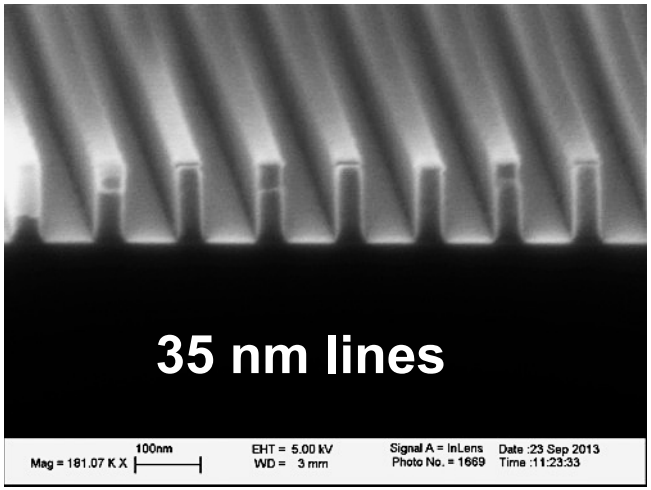
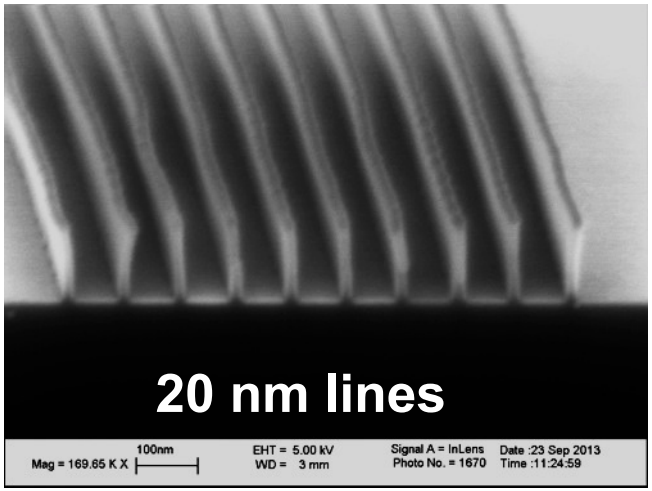
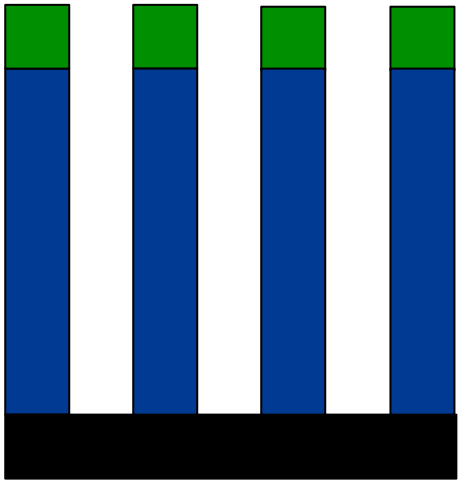
Pattern Transfer: Etch into SOC

SPIE'14







20nm Inpria Resist

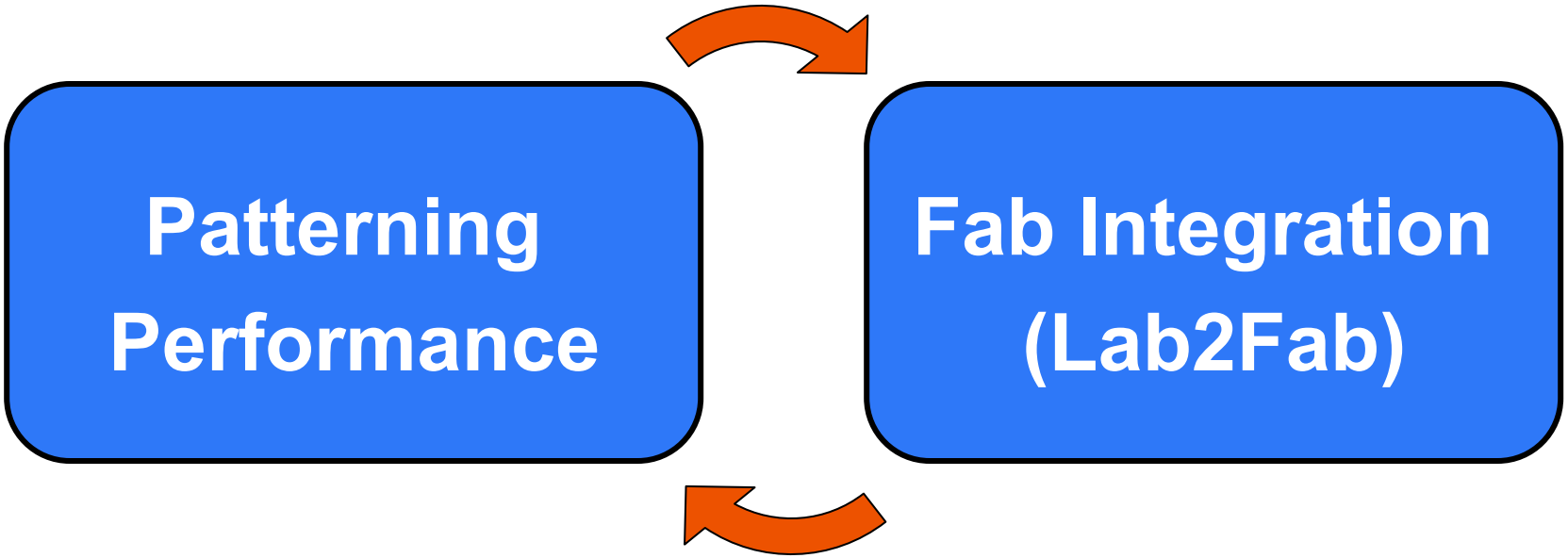
100nm Spin-on-Carbon

EB expose

O_2:N_2 etch

High selectivity provides large process window for SOC open

The Path Ahead



Further improvements in RLS

Full support for regular sampling on NXE33x0

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Thank You!

- Inpria team
- LBNL & SEMATECH
  - Chris Anderson, Patrick Naulleau, and MET team
- PSI
  - Yasin Ekinci, Michaela Vockenhuber, and team
- IMEC
  - Danilo De Simone, Ivan Pollentier, Mieke Goethals, Geert Vandenberghe, and team

- ... and to all of our partners

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